

SESSION PAPERS



OVERVIEW & VISION

STANDARD TEST EQUIPMENT PLATFORM (MODULES)

GWTS UPGRADE

COMMON ATS ARCHITECTURE

HARDWARE

SOFTWARE



AIRCRAFT INTERFACE EXAMPLE

MISSILE AUR ATS EXAMPLE





GUIDED WEAPONS TEST STATION UPGRADE A COOPERATIVE EFFORT WITH TAIWAN

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GWTS UPGRADE - INTRODUCTION



- □ Since mid-1970's the Navy has been Seeking a Common Missile Tester:
 - Naval Air Systems Command/Pacific Missile Test Center (PMTC)
 System Test Equipment Program (STEP) 1972 -1975
 - Hughes Aircraft Company (HAC) PHOENIX/AMRAAM Test Concept 1982
 - Joint Navy/Industry Common Tester Study 1983 to 1984
 - Joint Navy/HAC PHOENIX Tester Upgrade 1984 to 1986
 - PMTC PHOENIX Tester Upgrade (*Near Miss*: In Source Selection When Cancelled by CASS Mandate) 1986 - 1988
 - General Electric CASS Missile Test Station 1988 1991
 - PMTC CASS Missile Test Station 1991 -1992
 - Guided Weapons Test Station 1993 1998 Future



HIAK GWTS UPGRADE - INTRODUCTION (Cont.)



- □ Raytheon (HAC) Delivered Seven GWTS's in 1998
- □ Documented/Demonstrated Multi-Munitions Capable
- □ Problems Apparent Immediately
 - COTS Main Computer and Other Hardware Obsolete Even Before Delivery
 - Missile Maintenance Paradigm Shift from Organic to Some Variant of "O" to "OEM"
 - Acquisition Reform (AR) negated DOD Mandate to Use CASS and GWTS – Raytheon Opted for Factory Equipment in Lieu of GWTS/OTPS for Factory Depot
 - Users Wanted GWTS Upgraded to WINTEL No Schedule or Funding
- □ AMRAAM (Limited) and ESSM only Customers
- □ NAVAIR Transitioned Program to NAWC-WD Led JOIPT Complete 4/99



GWTS UPGRADE - INTRODUCTION (Cont.)



Newly Approved Taiwan CSIST Consolidated Depot Concept = FMS GWTS Interest

- Memorandum of Agreement Between Taiwan and US Includes a GWTS and Funding for GWTS Upgrade
- Travel to Taiwan in 10/99 to Brief Senior Managers and Some Technical Staff RE GWTS Capabilities and Upgrade Scope
- Funds Received and Serious Work Began in 1/2000
- SDR (2/2000), Peer Review (4/2000 and PDR (8/2000) Complete
- Upgraded GWTS Delivery 1/2002





- Raytheon Designed GWTS Modular, Expandable and Adaptable to Meet Munitions Test Needs
- Design Synthesis Based on Test Requirements of 18 Mentions:
 - RF AMRAAM, Phoenix, Sparrow, Standard Missile (2),
 HARM, Harpoon, Tomahawk
 - Missile E-O Sidewinder, Chaparral, Stinger, Maverick,
 SLAM, RAM
 - Acoustic Mk46, MK48, MK48 ADCAP, MK50 Torpedoes
- Goal > 70 Percent of UUT Requirements in GWTS







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UUT FUNCTIONAL REQUIREMENTS	88	89	84	70	70	69	73	67	68	64	- 66	64	57	65	48	60	61	48
OTPS FUNCTIONAL PARITITION (%)	22	21	22	22	22	16	20	23	22	21	22	21	20	22	16	19	19	15
GWTS FUNCTIONAL PARTITION (%)	80	81	79	76	76	81	78	74	76	75	75	75	74	75	75	76	76	76



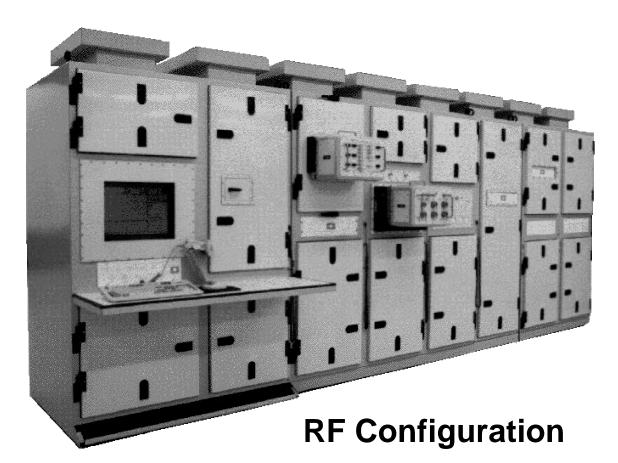


- GWTS AN/USM-659 V1 Base Systems Provides Controller Subsystem and LF Subsystem
- Base System Provides Computer and LF Resources Core – Analogous to CASS Hybrid
- Base System Provides Control and I/O Ports for Additional Subsystems and OTPS Hardware
- Delivered RF V2 Version Adds RF, Power and TM Subsystem and Ancillary Remote Work Station
- Notional Design Work Showed Feasibility of E-O and Acoustic Target Subsystems – Detail Development Beyond Scope of Original Contract



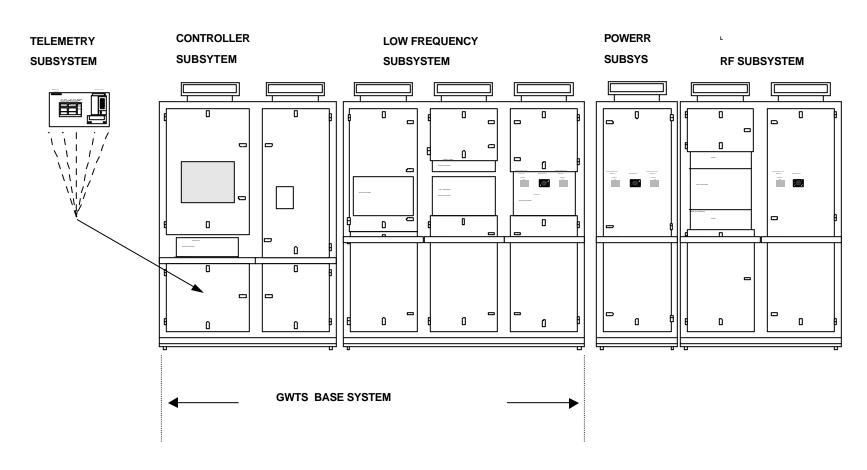
AN/USM-659 (V)1 GWTS







• AN/USM-659 V1 Base and V2 RF Configurations

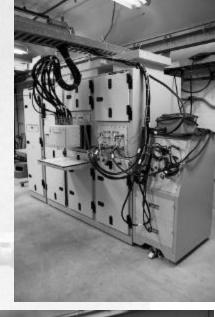




GWTS













- Design Maximizes COTS
 - DEC Alpha 190 MHz and Peripherals
 - VXI Used Where It Met Functional Requirements
 - IEEE-488 Used Where VXI Instruments Did Not Meet Requirements
- Multiple Bus Backbone
 - VXI Control and I/O via Fiber-Optic High Speed Data Bus with MXI Extensions in RF Subsystem
 - IEEE-488 Instruments Controlled Via Ethernet and Ethernet/ 488 Converters
 - Separate Ethernet Buses for TM Subsystem and LF DTU Control Computer
 - HSD and Ethernet Busses Available for New Subsystems and OTPS's





- Software Design
 - DEC/COMPAQ UNIX 3.2B On System Controller
 - Ada Supplemented By C Programming Language for Applications Including GWTS Executive, Utility and Station Self-Test/Calibration
 - Almost All VXI Drivers Adapted From COTS Windows
 - Rational Apex Ada IDE and SW CM Tool
 - Test Executive Provides API TE Linked and Compiled In All Program Groups
 - TP Template Provides Form and Content for Future Test Program Development
 - Self-Test Includes Background Instrument BIT and Flexible End-to-End BIT and Functional Tests
 - Initial and Periodic Calibration



GWTS UPGRADE DESCRIPTION SCOPE



- Replacement of DEC Alpha AND UNIX With More Supportable Hardware and Software
- Elimination of Obsolete DEC/VMS DTU Controller Computer
- Replacement of HP/Agilent E1410A's with E-1412A's
- Rehost Entire GWTS Software Suite From DEC Alpha and UNIX to New Hardware and Software
- Systems Integration Tests
- Documentation Updates
- Training Design and Implementation
- Final US Acceptance Testing



GWTS UPGRADE DESCRIPTION USN/RAYTHEON COOPERATION



- Raytheon Invited to Participate in Upgrade Effort
 - Provided As-Available Access to Key GWTS Designers
 - Also Monitored Design at Design and Other Reviews
- Raytheon Invited Participation of Key Software Upgrade Personnel in Trade Studies for Future Common/Standard Missile Test Station
- GWTS Upgrade Management Delayed Final Selection of New Computer and Operating System Until Raytheon Trades Complete
- Studies Recommended Multi-CPU Pentium System with Windows NT
 - Computer and Software Coincided With GWTS Plans
 - Because GWTS Team Did Not Have Design Freedom Other Raytheon Architectural Recommendations Were Not Adopted



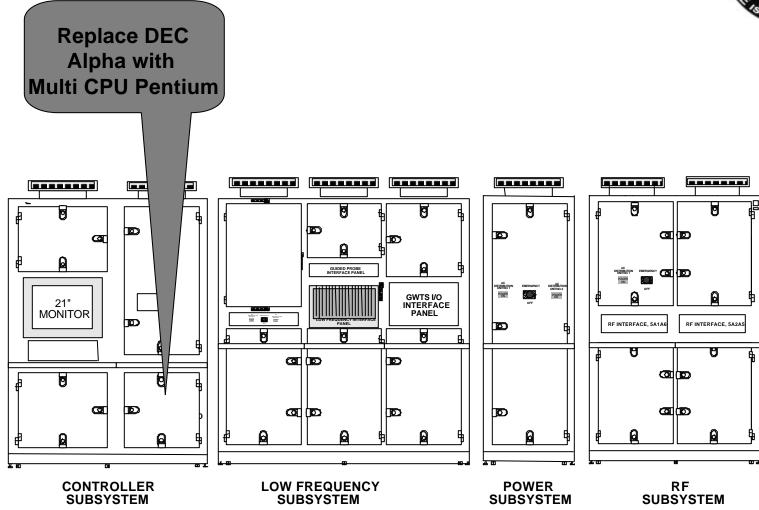


- Computer Replacement
 - Rack-Mounted Configuration From a Major Vendor
 - Pentium III or Higher and Camino 820 or Higher Chip Set Supporting a Minimum of Two Processors Running at 800MHz or Faster
 - 256 MB or Higher RAMBUS RDRAM
 - Six PCI Slots
 - Multi-Monitor Capable
 - DVD-DROM R/W and Floppy Disk
 - Retain Existing SCSI Removable Hard Drive and Magneto-Optic Drive
- Operating System Replacement
 - The First Choice is Windows 2000 BUT May Have To Settle for WIN NT4+ If Tools Are Not WIN2000 Compliant



GWTS Computer Upgrade









Software Rehost

- The Intent Is to Transfer as Much Much Ada/C Code As Possible
- No Change in the Basic Software Architecture is Planned
- About 400,000 Lines of Code to be Functionally Rehosted

Scope of Effort

- Instrument Driver Acquisition and Compilation
- Rational Apex Direct Imports Analysis
- Install NT4/2000 In and Transfer Source Code to New GWTS Control Subsystem Computer
- Build Library Files I.e. UNIX .a Files → NT/2000 .DLLs
- Recreate UNIX GUI Screens in NT/2000 and Link New Screens to New GWTS User Information Manager





- Software Rehost Scope of Effort (cont)
 - Recreate GWTS Database Functionality (Currently in Informix using SQL Commands Created By an Apex Tool -Ada/SAME – Not Available in NT/2000
 - Data Manager Subsystem
 - Executive Manager Subsystem
 - Self-Test Subsystem
 - BMC LOC
 - Calibration Subsystem
 - Test Program Template
 - Instrument Editor
 - Path Editor
 - System Configurator
 - Test Editor
 - Test Program Configurator





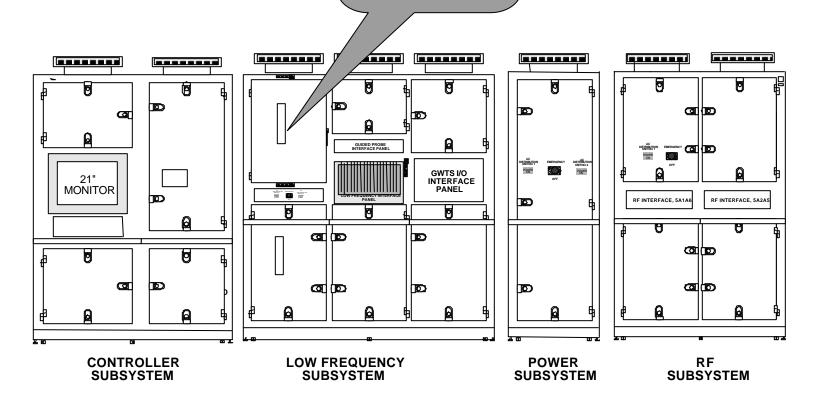
- Digital Multimeter Replacement
 - Straight-Forward Replacement of Obsolete
 E1410A with Current E1412A
 - E1412A Capabilities are Equivalent to 1410A and Conform to PIDS Requirements in Relevant Areas
 - Drivers Not Interchangeable
 - Part of Software Rehost is Integration of New Driver



GWTS DMM Upgrades



Replace Two E1410A with E1412A DMM'S







DTU and DTU Computer Replacement

Replacement of current DTU with Two Talon SR192 Digital Modules Allows Deletion of Obsolete DEC/Compaq Alpha DTU Control Computer

Talon Module Chosen on Basis of Price by GSA - Both Bid on Same Procurement Specification

Talon Matches DTU and GWTS Prime Item Development Specification (PIDS) in all Substantive Areas

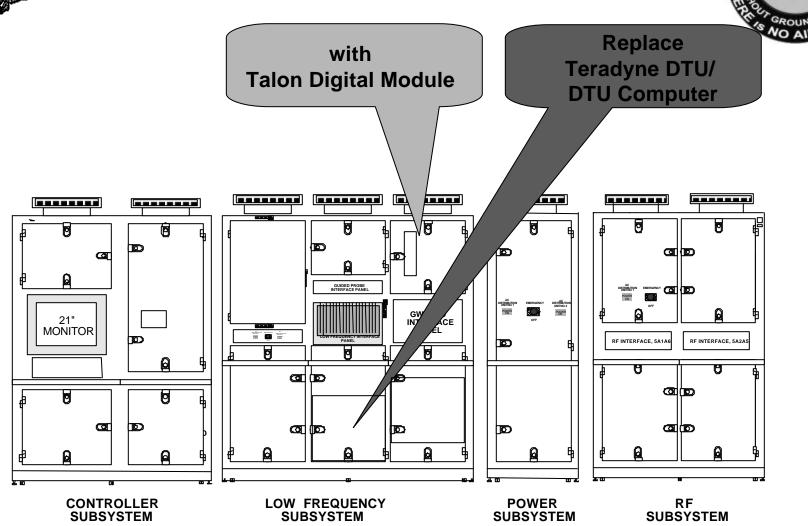
Talon Modules Will Fit Into Existing VXI Chassis

Talon will Reduce Support Costs with Lower Procurement and Repair Cost, Higher Intrinsic Reliability, Improved LF Subsystem Reliability Through Reduced Heat Load.

Talon Installation Will Free Up About 1/6 of LF Subsystem Volume



GWTS DTU Upgrade







- System Integration Tests
 - Module Tests Test of Each Individual Software
 Module as Independently As Possible
 - Incremental Tests Will be Conducted as Software-Software and Software-Hardware Integration Progresses - Object is to Find Problems as Early as Possible
 - End-To-End Tests will be Conducted when All Rehosted Software and New Hardware Is In Place





- Documentation Updates
 - Software and Hardware Design Documentation Will be Updated to Reflect Upgrade Changes - Specifications and Drawings
 - User Documentation Including Technical Manuals, Test Program Set Development Guide and CRISD Software Load Instructions will be Upgraded to Reflect New Configuration
 - Configuration and Data Management Interface GWTS DM and DM Will Revise/Approve Document Changes and Freeze the Official Upgrade Documentation





- Training Design and Presentation
 - Original Raytheon Operator and Maintainer Training
 Materials will be Updated to Incorporate Upgrade Related
 Changes
 - Using Available (I.e. TPS Developer's Guide, Software SPS and CRISD) and New-Development Data, A New Test Program Development Training Curriculum Will be Developed
 - Training Will Be Provided at Point Mugu to Taiwan Representatives - First the Operator and Maintainer Course and Then TPS Developer's Course





Acceptance Demonstration

- To Maximize Customer Confidence In Upgraded Station an Acceptance Demonstration Comparable in Scope to The GWTS Joint Acceptance Demonstration Will Be Planned and Conducted in US before Upgrade GWTS Shipment
- Like JAD, The New Demonstration will Prove Conformance to GWTS PIDS Through a Self-Test, Calibration and Where Necessary, Special Tests, Analyses and Inspections



Challenges



- □ Upgrades of COTS-based systems provide challenges in:
 - Configuration Management
 - COTS element compatibility
- □ COTS elements applied to COTS applications typically face lifetimes of 1-2 years
- □ COTS elements used for military applications must endure lifetimes of 20+ years



Configuration Management



- □ COTS upgrades to hardware, software, firmware and tools are each managed with their own version control
- Upgrades and version changes occur independently for each element, making coordination and block-upgrade timing difficult
- □ "Promises" of 20 year support may be overstated
- □ Users have no control over support for older versions



- □ As versions of COTS items change, compatibility must be revalidated
- COTS components which support multiple platforms do not necessarily guarantee compatibility across platforms
- ☐ There is no guarantee that all COTS vendors will provide upgrade paths



PRODUCT ENVIRONMENT DIFFERENCES



CRITERIA	MILITARY	COMMERCIAL
PRODUCT LIFE	20 YEARS +	1 MONTH - 3 YEARS
THROUGHPUT	SEVERAL/YEAR	THOUSANDS/YEAR
DESIGN AGENT ACCESS	NONE	IMMEDIATE
ATE TYPE	GENERAL PURPOSE	SPECIAL PURPOSE
IMPACT OF FAILURE	MISSION FAILURE	WARRANTEE RETURN
OPERATOR UUT FAMILIARITY	LOW	HIGH
TEST OBJECTIVE	SYSTEM READINESS	COST/UNIT YIELD
ACCEPTANCE CRITERIA	FORMAL DEMO(S)	PRODUCTION LINE PERFORMANCE
ETC	ETC	ETC



THE TEN COMMANDMENTS OF COTS



The Following Extracts are taken from a Carnegie-Mellon Paper

- 1. Do Not Believe in "Silver Bullets"
- 2. Use the Term Precisely and Demand the Same from Others.
- 3. Understand the Impact of COTS Products on the Requirements & Selection Process
- 4. Understand COTS Impact on the Integration Process
- 5. Understand COTS Impact on the Testing Process

- 6. Realize that a COTS Approach makes a System Dependent on the COTS Vendors.
- 7. Realize that Maintenance is Not Free
- 8. You are Not Absolved of the Need to Engineer the System Well.
- 9. Just "Doing COTS" is not an Automatic Cost Saver.
- 10. "Doing COTS" must be part of a Large-Scale Paradigm Shift"

Source: "The Commandments of COTS" - Carney & Oberndorf, Software Engineering Institute, Carnegie Mellon University. Published in Crosstalk, May 1997



COTS Summary



- □ COTS offers reduced development cost and schedule, but is not a panacea
- COTS challenges are significant, and must be factored into the entire support lifecycle



Cost of Ownership



- Application of ATS standardization strategies offer significant savings in total cost of ownership
- □ COTS applications assist in reducing costs and schedules - BUT -
- COTS application to military environments poses new challenges which must be identified and addressed

There is <u>still</u> no "Free Lunch"



CONCLUSIONS AND SUMMARY



- Baseline GWTS Is a Powerful Tester That Offers Standardization Across Weapons and Users
- COTS/standardization Provide Opportunities for Radical Reduction in Total Ownership Costs
- Standardization Is the Foundation for Weapons and Users Interoperabilty Improvements
- Total Ownership Costs Are Further Reduced through Cooperation Among Government, Industry and FMS Users
- The GWTS JOIPT and Upgrade Team Are Grateful for Assistance and Cooperation of Raytheon and Taiwan MND